Res Ligusticae
CCXXXVI

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THE SPONGE POPULATION OF TINO AND TINETTO ISLANDS (LIGURIAN SEA): DISTRIBUTION AND ABUNDANCE OF THE MOST CONSPICUOUS SPECIES

(PORIFERA)

INTRODUCTION

The sponge fauna of the island complex in the Gulf of La Spezia (Ligurian Sea, NW Mediterranean) has remained largely unstudied, without any systematic examination being carried out in the area. Just one reference on the distribution of conspicuous sponge species thriving on a rocky shoal off Tino Island is reported in the literature (Cocito *et al.*, 1997). In the eastern part of the Ligurian Sea, on the contrary, more extensive studies on sponge distribution considered the Portofino and the neighbouring areas (Sarà 1964; 1966; Pansini & Pronzato, 1973; 1975; Sarà *et al.*, 1978). Other studies referred to the distribution and ecology of sponges on muddy and detritic bottoms of Ligurian and Tyrrhenian Seas (Pansini & Musso, 1991).

The studied area shows some peculiarities which influence the bathymetric distribution of benthic assemblages: the high seawater turbidity (mean value of transparency 9.5 m, Bassano *et al.*, 2000), the highest recorded in the Ligurian Sea, and the deposition of large amount of sediment (Morganti *et al.*, 2001). These two factors shift the upper limit of distribution of sciaphilic assemblages (Cocito *et al.*,

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2001) to shallower depths than usually reported (GILI & ROS, 1985). Notwithstanding the closeness to the port of La Spezia, seawater is characterised by oligotrophy (CERRATI *et al.*, 2000).

The aim of the present study was to identify the most conspicuous sponges inhabiting the different benthic communities of Tino and Tinetto Islands and to evaluate their general distribution patterns.

MATERIAL AND METHODS

Tino and Tinetto Islands (44° 01' N, 9° 50' E) are located at the western border of the Gulf of La Spezia (Fig. 1). The study area receives a great input of terrigenous material from the Magra River (DAMIANI *et al.*, 1989), the biggest in the region, and is subjected to the influence of the town of La Spezia.

The lithology of the islands consists of carbonate outcrops and includes thin layers of the famous marble called "portoro". The islands show similar coast morphologies: the western side of both has vertical walls, while the eastern one slopes down. They are surrounded by a flat, muddy bottom with an average depth of about 26 m.

Sampling was carried out in August and September 1999 by means of SCUBA diving. Six sites (Fig. 1), from A to F, with different bottom morphology and exposure were chosen to cover the largest number of different habitats. At each site, two 5 m-wide visual transects were surveyed from the bottom to the surface, recording substratum exposure, depth and inclination, sponge species and benthic communities.

Sponges, whose identification was not sure by observation in the field, were photographed underwater using a Nikonos V camera equipped with a close-up attachment to a 35 mm lens (reproduction ratio 1:3) and a field frame, then collected and preserved in ethanol. Spicule preparation for light microscopy was made by dissolving small fragments of specimens in 65% nitric acid, both in test-tubes and directly on slides, rinsing with water, dehydrating with 90% ethanol and mounting in Eukitt resin. The spongin skeleton of horny sponges was manually cleaned, dehydrated and mounted in Eukitt resin.

Sponge cover was quantified along the transects using a visually estimated relative abundance index ranging from 1 to 4 (1 = present, 2 = 1 - 10% cover, 3 = 11 - 40% cover, 4 = > 40% cover).

RESULTS

A total of 44 sponge species were recorded, 2 of which belonging to Calcarea and 42 to Demospongiae (Table 1). The majority were found on vertical walls or on blocks, two exclusively inside crevices (*Clathrina cerebrum* (Haeckel) and *Aplysilla sulfurea* (Barrois)) and two in cave (*Erylus euastrum* (Schmidt) and *Penares helleri* (Schmidt)).

Sites A, B and C, which had similar topography, displayed also a similar number of species (34, 34 and 38 respectively); sites D and E, both facing east and with slightly different topography, showed 27 and 5 species respectively, whereas in site F, close to the Tinetto cave, 10 sponge species were found (Fig. 2).

Site A was located on the northern side of Tino Island (Fig. 1), where the coast profile shows vertical walls going down to 16 – 18 m depth, then it gently slopes down until 28 m being characterised by the presence of blocks and boulders on the bottom. In the first 5 – 10 m, among semi-sciaphilic algal communities (encrusting corallineae and the brown algae *Dyctiopteris membranacea* (Hudson) Lamouroux), the most common sponge species were *Cliona celata* Grant, *Cliona nigricans* (Schmidt), *Ircinia spinosula* (Schmidt) and *Spongia virgultosa* (Schmidt); other sponges were found exclusively in crevices (*Clathrina cerebrum*). A sciaphilic algal community dominated by *Cystoseira zosteroides* (Turner) C. Agardh was present: among the seaweed rhizoids or in dark enclaves down to 16 m depth, *Chondrosia reniformis* Nardo, *Spirastrella cunctatrix* Schmidt, *Petrosia ficiformis* (Poiret) were found, as well as large specimens of *Spongia agaricina* Pallas and *Spongia officinalis* Linné. *Chondrilla nucula* Schmidt was noted only in this site, on the upper face of rocks at 11 m of depth. Where the rocky substratum faded away towards a muddy bottom with sparse blocks, some small patches of the gorgonian *Paramuricea clavata* (Risso) coralligenous' facies were substituted by a *Leptogorgia sarmentosa* (Linnaeus) facies. Sponge communities were mostly abundant on the vertical walls of blocks and in crevices. *Dysidea avara* (Schmidt) was the most conspicuous species, reaching 50% substratum cover, followed by *Axinella damicornis* (Esper), *Scopalina lophiropoda* Schmidt and *Sarcotragus foetidus* (Schmidt) that has a massive habit.

Site B showed species richness similar to site C and A, but lower cover values. The site, on the western side of Tino Island, was characterised by a reduced cover of the sciaphilic algal community (*Peys-*

Table 1 - List of sponge species found in the six sites and relative abundance index (1 = present, 2 = 1 - 10% cover, 3 = 11 - 40% cover, 4 = > 40% cover). Depth range and substratum preference are reported.

Species	Sites						Depth	Substratum preference
	A	B	C	D	E	F		
Class Calcarea								
Order Clathrinida								
Clathrina cerebrum (Haeckel, 1872)	2	2	3	2	2		1-10	crevice
Clathrina clathrus (Schmidt, 1864)	2	2	3	2			16-24	wall, crevice, block
Class Demospongiae								
Order Homosclerophorida								
Oscarella lobularis (Schmidt, 1862)	3	2	4	2		2	10-24	wall, crevice, block, cave
Order Astrophorida								
Erylus euastrum (Schmidt, 1868)						2	20-22	cave
Penares helleri (Schmidt, 1864)						1	20	cave
Stelletta stellata Topsent, 1893		1					15	wall
Order Hadromerida								
Aaptos aaptos (Schmidt, 1864)			2			1	15-21	crevice, wall
Chondrilla nucula Schmidt, 1862	2						11	block
Chondrosia reniformis Nardo, 1847	3	3	4	3		3	4-24	wall, crevice, block, cave
Cliona celata Grant, 1826	3	2	3	3	2		1-20	wall, crevice, block
Cliona nigricans (Schmidt, 1862)	3	3	3	3	3		1-24	wall, crevice, block
Cliona sp.	2	2	3	2			15-24	wall, crevice, block
Cliona viridis (Schmidt, 1862)	2	1	2	3		2	10-24	wall, block, crevice
Spirastrella cunctatrix Schmidt, 1868	3	2	3	2			12-24	wall, block, crevice
Order Agelasida								
Agelas oroides (Schmidt, 1864)	3	2	4	2		2	15-26	wall, crevice, block
Order Poecilosclerida								
Crambe crambe (Schmidt, 1862)	2	3	3	2			10-24	wall, block, crevice
Pronax fibulatum Topsent, 1893			1				18	wall
Microciona atrasanguinea Bowerbank, 1866			1				17	wall
Eurypon major Sarà & Siribelli, 1960	3	2	3	2			15-25	wall
Raspaciona aculeata (Johnston, 1842)	2	1	2	1			15-25	wall, block
Order Halichondrida								
Acanthella acuta Schmidt, 1862	3	2	3	2			10-26	wall, block
Axinella cannabina (Esper, 1794)	1	2	3				10-25	wall
Axinella damicornis (Esper, 1794)	4	3	4	3	1		10-26	wall, crevice, block, cave

Axinella polypoides Schmidt, 1862	3	2	3				15-26	wall, block
Axinella verrucosa (Esper, 1794)	2	1	3				15-26	wall
Dictyonella incisa (Schmidt, 1880)			1				17	wall
Scopalina lophyropoda Schmidt, 1862	4	2	3	2			15-24	wall, block
Topsentia aurantiaca (Schmidt, 1862)	2						17-20	wall, block
Order Haplosclerida								
Haliclona mediterranea Griessinger, 1971	2	2	3				8-24	wall, crevice, block
Petrosia ficiformis (Poiret, 1789)	4	2	4	3		3	10-24	wall, crevice, block, cave
Order Dictyoceratida								
Cacospongia scalaris Schmidt, 1862	3	2	2	2			12-24	wall, block
Dysidea avara (Schmidt, 1862)	4	2	3	3	4		14-24	wall, block, pebbles
Dysidea fragilis (Montagu, 1818)	2	1	2	2			12-24	wall, block
Ircinia spinosula (Schmidt, 1862)	2	1	3	2		1	1-24	wall, crevice, block, cave
Ircinia variabilis (Schmidt, 1862)	2	2	3			2	10-24	wall, crevice, cave
Sarcotragus foetidus (Schmidt, 1862)	4	3	4	2			8-24	wall, block
Spongia agaricina Pallas, 1776	3	3	4	1			12-24	wall, block
Spongia officinalis Linné, 1759	3	3	4	3			5-24	wall, block, crevice
Spongia virgultosa (Schmidt, 1868)	2	1	1	2			1-15	wall, crevice
Order Dendroceratida								
Aplysilla sulfurea (Barrois, 1876)		3					17-22	crevice
Hexadella racovitzai Topsent, 1896			1				16	wall
Pleraplysilla spinifera (Schulze, 1878)	3	1	4				10-24	wall, crevice, epibiont
Order Verongida								
Aplysina aerophoba Schmidt, 1862			1				16-19	wall
Aplysina cavernicola Vacelet, 1959	2	3	4	1			15-26	wall, crevice, block

sonnellia sp., *Flabellia petiolata* (Turra) Nizamuddin) and, at a deeper level, by the presence of the gorgonians *Eunicella singularis* (Esper) (depth range 10 - 18 m) and *Leptogorgia sarmentosa* (from about 15 m until the muddy bottom at 27 m). Crevices on the wall hosted a sponge community where *Aplysina cavernicola* Vacelet was the most conspicuous species, with cover values higher than in the rest of the site. *Crambe crambe* (Schmidt) and boring clionid sponges were also common. *Stelletta stellata* Topsent and *Aplysilla sulfurea* were found exclusively in this site. At the base of the vertical cliff several specimens of *Axinella polypoides* Schmidt with an average height of 30 cm were found.

Site C showed the greatest species richness and the highest substratum cover. The site was located on the vertical wall of the western side of Tinetto Island. Its exposure and the presence of a lot of crevices made it a shady habitat. A rich population of the gorgonian *Paramuricea clavata* thrived on the upper layer from about 14 down to 22 m depth. At a lower layer, *Oscarella lobularis* Schmidt, *Agelas oroides* (Schmidt), *Haliclona mediterranea* Griessinger, *Axinella damicornis, Acanthella acuta* Schmidt attained the highest abundance. *Peraplysilla spinifera* (Schulze) was common and grew, as well as *O. lobularis*, as epibiont on the bryozoan *Myriapora truncata* (Pallas). It is noteworthy the presence of a specimen of *Aplysina aerophoba* Schmidt, found at 16 m depth, and one of *Microciona atrasanguinea* Bowerbank at 17 m depth. *Aaaptos aaptos* (Schmidt), *Dictyonella incisa* (Schmidt), *Pronax fibulatum* Topsent and *Hexadella racovitzai* Topsent were found exclusively in this site, from 15 to 18 m depth on the vertical wall. On the blocks scattered on the muddy bottom, where a rich population of the gorgonian *Leptogorgia sarmentosa* lived, the sponge *Aplysina cavernicola* showed the highest cover values (40-50% of substratum).

Site D, facing east, was positioned along a medium inclination slope (40-45°) with several steps. Semi-sciaphilic (*Sphaerococcus coronopifolius* (Goodenough et Woodward) C. Agardh, *Halopteris filicina* (Grateloup) Kützing) community followed by sciaphilic algal community (*Flabellia petiolata, Peyssonnellia* sp.) characterised the first depth layer (1 – 10 m) and the horizontal portions of substrata; the bryozoan *Pentapora fascialis* (Pallas) and the gorgonian *Eunicella singularis* represented the most relevant zoobenthic components and were followed, down to 17 m depth, by a rich population of *Leptogorgia sarmentosa*. Sponges were found mainly on the vertical portions of the steps. On the bottom some specimens of *Sarcotragus foetidus* and, on the (sub)horizontal substrata, a lot of boring clionids (*Cliona celata*, *C. nigricans* and *C. viridis* (Schmidt)) were found.

Site E at Tino Island faced east and the bottom had medium inclination with gravel and organic detritus. A film of sediment covered with a thin layer the substratum. Reduction in biotic cover was evident for both algal and animal taxa. *Dysidea avara* was able to live in this habitat reaching cover values of more than 40%; few clionids and some specimens of *Clathrina cerebrum* were present in small crevices.

Site F corresponded to the entrance of a cave found on the northwestern side of Tinetto Island. A sciaphilic algal community (*Flabellia petiolata, Peyssonnellia* sp.) with a few sponges (*Ircinia spinosula, Chondrosia reniformis*) thrived on the wall close to the opening of the

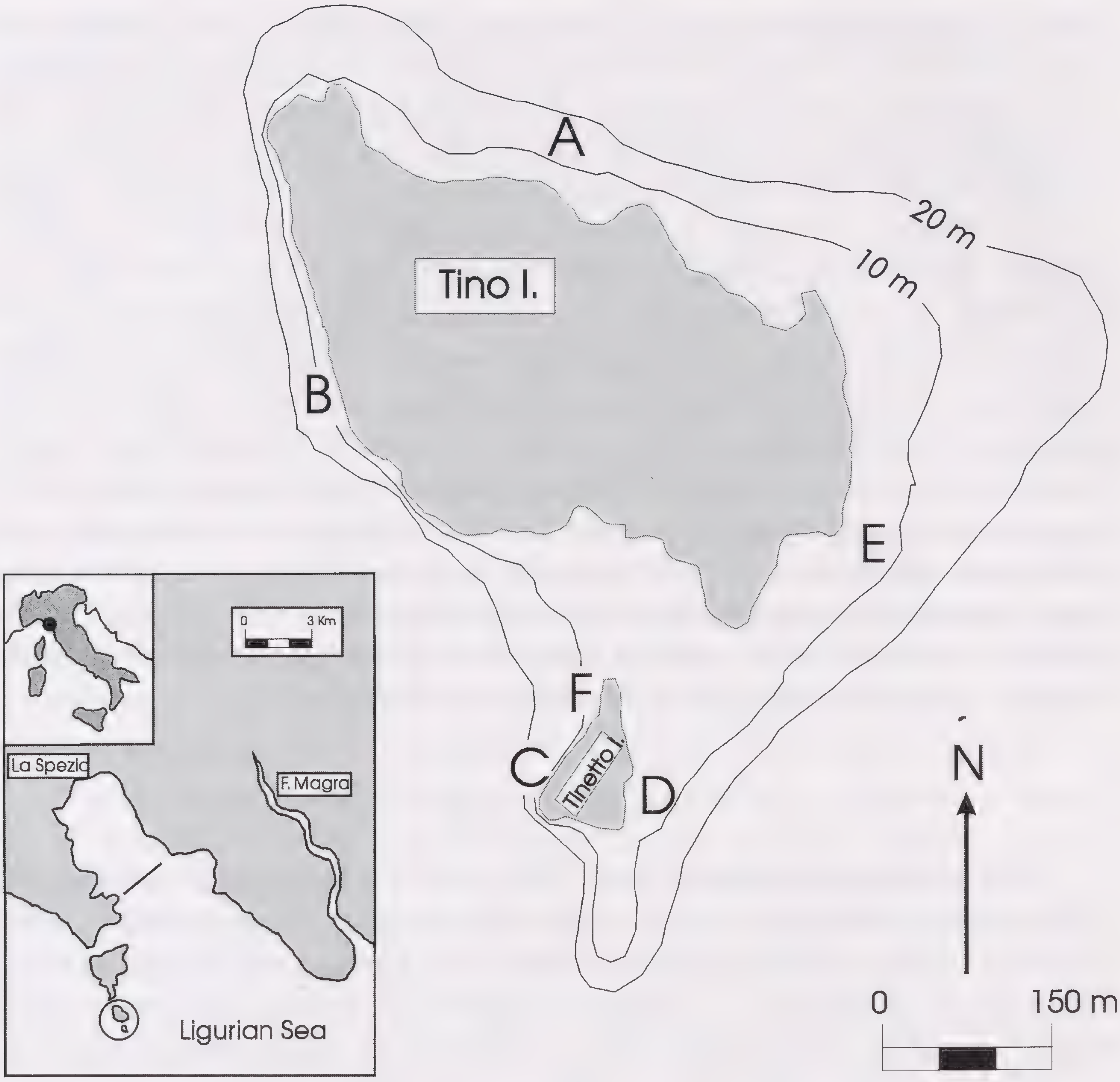

Fig. 1 - Study area and location of the studied sites (from A to F).

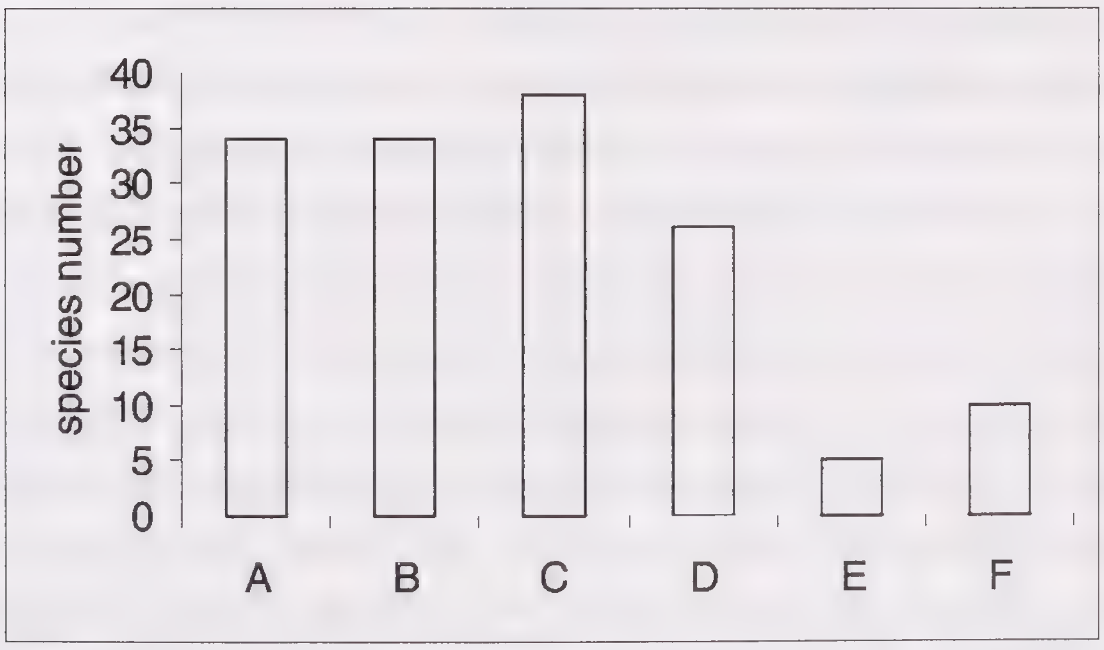

Fig. 2 - Number of sponge species found in each site.

cave. The cave vaulted roof is at about 15 m depth and the base at 20 m; it is 35 m long and 6 m wide. Sponge investigation was limited to the entrance. At the opening an elevated stratum was absent; the concretion stratum was mainly due to the red alga *Peyssonnellia* sp., substituted by encrusting corallinaceae under overhangs. The light reduction at the entrance of the cave favoured the presence of a 'community of the semi-obscure caves' that thrived on the walls and the roof. The most common species were anthozoans (*Leptopsammia pruvoti* Lacaze-Duthiers, *Caryophyllia inornata* (Duncan), *Polycyathus muellerae* (Abel)) and sponges. *Chondrosia reniformis* and *Petrosia ficiformis* were found in large numbers, *Oscarella lobularis* and *Agelas oroides* were rather abundant, *Erylus euastrum* and *Penares helleri* were found exclusively inside the cave. The cave floor gently sloped down with large blocks and boulders on the bottom. There, a hard substratum community, comparable to the coralligenous one of the 'lower belt of the littoral rock' was dominated by large colonies of *Pentapora fascialis* and a few sponges (*Chondrosia reniformis*).

DISCUSSION

The sponge species found at Tino and Tinetto Islands correspond rather well to the sponge fauna typically found in most subtidal rocky bottoms of the western Mediterranean Sea. Sponge communities show the highest richness on vertical substrata and most species exhibit higher cover on shaded substrata, conforming to a known distributional pattern (Sarà, 1968; Sarà & Vacelet, 1973).

Clionids, that are known to bore preferentially into calcareous substrates (Bavestrello *et al.*, 2000), which are the main component of the islands rocks, thrive in this habitat.

The high seawater turbidity and the deposition of large amounts of sediment, which characterise the studied area, are among the main hindrances to the life of sponges, clogging their aquiferous system and stopping respiration and feeding (Sarà & Vacelet, 1973). Among the *Leptogorgia sarmentosa* community, typical of muddy detritic bottoms, sponges are, in fact, more common on the vertical walls of blocks and into crevices. *Dysidea avara*, which is well adapted to detritic substrates, is the only species able to grow in large patches on the eastern sides of both islands characterised by high sediment deposition (Morganti *et al.*, 2001). The largest specimens of *Spongia agaricina* are to be found on vertical substrata, because they can catch the water flow by their fan or cup shaped bodies, being scarcely disturbed by the fine suspended particles.

The gravel bottom, found on the eastern side of Tino Island, prevents sponge settlement, as observed in areas of unstable substrates subject to currents (GINN *et al.,* 2000).

Notwithstanding the high seawater turbidity in the area, which, reducing light penetration, shifts benthic assemblages to shallower depth, the depth distribution of some species is rather unusual. *Chondrilla nucula*, that is very common on horizontal rocks (1-6 m) in the region of Marseille (VACELET, 1959), in the Ligurian Riviera (SARÀ, 1964) and in the Adriatic Sea (RÜTZLER, 1965), is noted at 11 m depth. One specimen of Aplysina aerophoba, typical of white calcareous substrata and shallow water (PANSINI, 1997; WILKINSON & VACELET, 1978), is found at 16 m depth. *Microciona atrasanguinea*, another typical shallow water species (SARÀ *et al.,* 1978), is found at 17 m depth. In addition, all these three species are noted on the northern (A) and north-western sites (C) investigated, where illumination is reduced.

On the contrary, an example of upward shift to a shallower habitat is that of Axinella polypoides (recorded at 15 m depth) that is reported to live normally in deeper waters (URIZ, 1982; BIANCHI & MORRI, 1994). Sponges are less sensitive to mere depth variations than to other depth related factors as light and water-movement (PANSINI *et al.,* 1977; BALDUZZI *et al.*, 1990). Therefore the unusual depth preferences shown by several sponge species may well be a consequence of the high turbidity of the studied area that smoothes the differences of light - the most important factor together with water-movement in determining sponge distribution - among depth levels.

The presence at Tino and Tinetto Islands of *Axinella cannabina* (Esper) is noteworthy, because it is indicated as a thermophylous species (BIANCHI & MORRI, 1994; PANSINI, personal observation) which becomes common in the mean and southern Tyrrhenian Sea.

In the weeks following the sampling period a mass mortality event involving a large number of invertebrates (CERRANO *et al.*, 2000) occurred in several regions of the western Mediterranean Sea. Since early September, at Tino and Tinetto Islands several shallow water specimens of *Spongia officinalis, Spongia virgultosa* and *Cacospongia scalaris* Schmidt were covered by a white coat of dead cells and in a few days only the spongin skeleton remained on the substratum. Later on the phenomenon interested deeper specimens and involved also the large specimens of *Spongia agaricina* living at about 12 m depth. Almost 100% of the involved specimens died.

Comparison between pre- and post-mortality sponge populations existing at Tino and Tinetto Islands will be very informative of changes in abundance and composition of Poriferan fauna caused by a disruptive and episodic disturbance event, and, in case of long-term studies, on the ability of this fauna to withstand or to recover from such events.

ACKNOWLEDGEMENTS

We thank Sergio Sgorbini (La Spezia), who helped with the diving work.

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SUMMARY

The abundance, distribution and species richness of the sponges inhabiting the different benthic communities of Tino and Tinetto Islands (La Spezia Gulf, Ligurian Sea) were studied. A total of 44 sponge species (2 Calcarea and 42 Demospongiae) were recorded. Sponge communities showed the highest richness on vertical substrata and most species exhibited higher cover on shaded substrata. The depth distribution of some species showed unusual patterns, with downward shift (*Chondrilla nucula, Aplysina aerophoba* and *Microciona atrasanguinea*) and upward shift (*Axinella polypoides*). These depth preferences may well be a consequence of the high turbidity of the studied area that smoothes the differences of light among depth levels. *Dysidea avara* resulted to be the only species able to grow in large patches on the eastern sides of both islands, characterised by high sediment deposition.

RIASSUNTO

Sono state studiate l'abbondanza, la distribuzione e la ricchezza specifica delle spugne presenti nelle diverse comunità bentiche delle isole del Tino e del Tinetto (Golfo di La Spezia, Mar Ligure). Sono state identificate 44 specie (2 Calcarea e 42 Demospongiae). Le comunità a spugne mostrano la maggior ricchezza sui substrati verticali e la maggior parte delle specie presentano valori di ricoprimento più elevati sulle porzioni ombreggiate del substrato. La distribuzione di alcune specie mostra *patterns* inusuali, con spostamento verso il basso (*Chondrilla nucula, Aplysina aerophoba* e *Microciona atrasanguinea*) e verso l'alto (*Axinella polypoides*). Tali preferenze distribuzionali possono essere una conseguenza dell'elevata torbidità dell'acqua nell'area studiata che attenua le differenze di luce alle varie profondità. *Dysidea avara* risulta essere l'unica specie in grado di formare larghe chiazze sul lato est di entrambe le isole, caratterizzate da elevata deposizione di sedimento.